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The following is a summary of the author's five-stage model of adult skill acquisition, developed in collaboration with Hubert L. Dreyfus. An earlier version of this article appeared in chapter 1 of Mind Over Machine: The Power of Human Intuition and Expertise in the Era of the Computer *(1986, Free Press, New York).*

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Stage 1: Novice

Normally, the instruction process begins with the instructor decomposing the task environment into context-free features that the beginner can recognize without the desired skill. The beginner is then given rules for determining actions on the basis of these features, just like a computer following a program.

The student automobile driver learns to recognize such domain-independent features as speed (indicated by the speedometer) and is given rules such as shift to 2nd gear when the speedometer needle points to 10. The novice chess player learns a numerical value for each type of piece, regardless of its position, and learns the following rule: Always exchange if the total value of pieces captured exceeds the value of pieces lost. The player also learns to seek center control when no advantageous exchanges can be found and is given a rule defining center squares and one for calculating extent of control.

But merely following rules will produce poor performance in the real world. A car stalls if one shifts too soon on a hill or when the car is heavily loaded; a chess player who always exchanges to gain points is sure to be the victim of a sacrifice by the opponent who gives up valuable pieces to gain a tactical advantage. The student needs not only the facts but also an understanding of the context in which that information makes sense.

Stage 2: Advanced Beginner

As the novice gains experience actually coping with real situations and begins to develop an understanding of the relevant context, he or she begins to note, or an instructor points out, perspicuous examples of meaningful additional aspects of the situation or domain. After seeing a sufficient number of examples, the student learns to recognize these new aspects. Instructional maxims can then refer to these new situational aspects, recognized on the basis of experience, as well as to the objectively defined nonsituational features recognizable by the novice.

The advanced beginner driver uses (situational) engine sounds as well as (nonsituational) speed in deciding when to shift. He or she learns the following maxim: Shift up when the motor sounds like it is racing and down when it sounds like it is straining. Engine sounds cannot be adequately captured by a list of features, so features cannot take the place of a few choice examples in learning the relevant distinctions.

With experience, the chess beginner learns to recognize overextended positions and how to avoid them. Similarly, he or she begins to recognize such situational aspects of positions as a weakened king's side or a strong pawn structure, despite the lack of precise and situation-free definitions. The player can then follow maxims such as the following: Attack a weakened king's side. Unlike a rule, a maxim requires that one already have some understanding of the domain to which the maxim applies (Polanyi, 1958). Still, at this stage, learning can be carried on in a detached, analytic frame of mind, as the student follows instructions and is given examples.

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Stage 3: Competence

With more experience, the number of potentially relevant elements and procedures that the learner is able to recognize and follow becomes overwhelming. At this point, because a sense of what is important in any particular situation is missing, performance becomes nerve-wracking and exhausting, and the student might well wonder how anybody ever masters the skill.

To cope with this overload, and to achieve competence, people learn, through instruction or experience, to devise a plan or choose a perspective that then determines those elements of the situation or domain that must be treated as important and those that can be ignored. As students learn to restrict themselves to only a few of the vast number of possibly relevant features and aspects, understanding and decision making becomes easier.

Naturally, to avoid mistakes, the competent performer seeks rules and reasoning procedures to decide which plan or perspective to adopt. But such rules are not as easy to come by as are the rules and maxims given beginners in manuals and lectures. Indeed, in any skill domain, the performer encounters a vast number of situations differing from each other in subtle ways. There are, in fact, more situations than can be named or precisely defined, so no one can prepare for the learner a list of types of possible situations and what to do or look for in each. Students, therefore, must decide for themselves in each situation what plan or perspective to adopt without being sure that it will turn out to be appropriate.

Given this uncertainty, coping becomes frightening rather than merely exhausting. Prior to this stage, if the rules do not work, the performer, rather than feeling remorse for his or her mistakes, can rationalize that he or she had not been given adequate rules. But because at this stage the result depends on the learner's choice of perspective, the learner feels responsible for his or her choice. Often, the choice leads to confusion and failure. But sometimes, things work out well, and the competent student then experiences a kind of elation unknown to the beginner.

A competent driver, leaving the freeway on an off-ramp curve, learns to pay attention to the speed of the car not to whether to shift gears. After taking into account speed, surface condition, criticality of time, and so forth, the competent driver may decide he or she is going too fast. The driver then has to decide whether to let up on the accelerator, remove his or her foot altogether, or step on the brake, and precisely when to perform any of these actions. The driver is relieved if he or she gets through the curve without mishap and is shaken if he or she begins to go into a skid.

The Class A chess player, here classed as competent, may decide after studying a position that the opponent has weakened his or her king's defenses so that an attack against the king is a viable goal. If the player chooses to attack, he or she ignores weaknesses in his or her own position created by the attack, as well as the loss of pieces not essential to the attack. Pieces defending the enemy king become salient. Because pieces not involved in the attack are being lost, the timing of the attach is critical. If the competent player attacks too soon or too late, his or her pieces will have been lost in vain, and he or she will almost surely lose the game. Successful attacks induce euphoria, whereas mistakes are felt in the pit of the stomach.

If we were disembodied beings, pure minds free of our messy emotions, our responses to our successes and failures would lack this seriousness and excitement. Like a computer, we would have goals and succeed or fail to achieve them but, as John Haugeland once said of chess machines that have been programmed to win, they are good at attaining their goal, but when it comes to winning, they do not give a damn. For embodied, emotional beings like us, however, success and failure do matter. So the learner is naturally frightened, elated, disappointed, or discouraged by the results of his or her choice of perspective. And, as the competent student becomes more and more emotionally involved in the task, it becomes increasingly difficult to draw back and adopt the detached maxim-following stance of the advanced beginner.

But why let learning be infected with all that emotional stress? Have not we in the West, since the Stoics, and especially since Descartes, learned that to make progress, we must master our emotions and be as detached and objective as possible? Would not rational motivation, objective detachment, honest evaluation, and hard work be the best way to acquire expertise?

Although it might seem that involvement could only interfere with detached rule testing, and so would inevitably lead to irrational decisions and inhibit further skill development, in fact, just the opposite seems to be the case. Patricia Benner has studied student nurses at each stage of skill acquisition. She finds that, unless the trainee stays emotionally involved and accepts the joy of a job well done, as well as the remorse of mistakes, he or she will not develop further and will eventually burn out trying to keep track of all

the features and aspects, rules and maxims that modern medicine requires. In the cases of nurses at least, resistance to involvement and risk leads to stagnation and, ultimately, to boredom and regression (Benner, 1984).

In general, if one seeks the safety of rules, one will not get beyond competence. On the other hand, experiencing deeply felt rewards or remorse seems to be necessary for the performer to learn from examples without rules.

One might object that this account has the role of involvement reversed: that the more the beginner is emotionally committed to learning the better, whereas an expert could be, and, indeed, often should be, coldly detached and rational in his or her practice. This is no doubt true, but the beginner's job is to follow the rules and gain experience, and it is merely a question of motivation whether he or she is involved. Furthermore, the novice is not emotionally involved in choosing an action, even if he or she is involved in its outcome. Only at the level of competence is there an emotional investment in the choice of the perspective leading to an action. Then, emotional involvement seems to play an essential role in switching over from what one might roughly think of as a left-hemisphere analytic approach to a right-hemisphere holistic one.

Of course, not just any emotional reaction, such as enthusiasm or fear of making a fool of oneself or the exultation of victory, would do. What matters is taking responsibility for one's successful and unsuccessful choices, even brooding over them—not just feeling good or bad about winning or losing, but replaying one's performance in one's mind step by step or move by move. The point, however, is not to analyze one's mistakes and insights but just to let them sink in. Experience shows that only then will one become an expert.

Stage 4: Proficiency

As the competent performer becomes more and more emotionally involved in a task, it becomes increasingly difficult for him or her to draw back and adopt the detached, rule-following stance of the beginner. If the detached stance of the novice and advanced beginner is replaced by involvement, and the learner accepts the anxiety of choice, he or she is set for further skill advancement.

Then, the resulting positive and negative emotional experiences will strengthen successful perspectives and inhibit unsuccessful ones, and the performer's theory of the skill, as represented by rules and principles, will gradually be replaced by situational discriminations. Proficiency seems to develop if, and only if, experience is assimilated in this embodied, atheoretical way.

As usual, this can be seen most clearly in cases of action. As the performer acquires the ability to discriminate among a variety of situations, each entered into with involvement, plans are evoked, and certain aspects stand out as important without the learner standing back and choosing those plans or deciding to adopt that perspective. When the goal is simply obvious, rather than the winner of a complex competition, there is less doubt as to whether what one is trying to accomplish is appropriate.

At this stage, the involved, experienced performer sees goals and salient aspects but not what to do to achieve these goals. This is inevitable because there are far fewer ways of seeing what is going on than there are ways of reacting. The proficient performer simply has not yet had enough experience with the outcomes of the wide variety of possible responses to each of the situations he or she can now discriminate among to react automatically. Thus, the proficient performer, after spontaneously seeing the point and the important aspects of the current situation, must still decide what to do. And to decide, he or she must fall back on detached rule and maxim following.

The proficient driver, approaching a curve on a rainy day, may feel in the seat of one's pants that he or she is going dangerously fast. He or she must then decide whether to apply the brakes or merely to reduce pressure by some specific amount on the accelerator. Valuable time may be lost while making a decision, but the proficient driver is certainly more likely to negotiate the curve safely than the competent driver who spends additional time considering the speed, angle of bank, and felt gravitational forces to decide whether the car's speed is excessive.

The proficient chess player, who is classed a master, can recognize almost immediately a large repertoire of types of positions. He or she then deliberates to determine the move that will best achieve his or her goal. One may know, for example, that he or she should attack, but he or she must calculate how best to do so.

Stage 5: Expertise

The proficient performer, immersed in the world of his or her skillful activity, sees what needs to be done but decides how to do it. The expert not only sees what needs to be achieved; thanks to his or her vast reper-

toire of situational discriminations, he or she also sees immediately how to achieve this goal. Thus, the ability to make more subtle and refined discriminations is what distinguishes the expert from the proficient performer. Among many situations, all seen as similar with respect to plan or perspective, the expert has learned to distinguish those situations requiring one reaction from those demanding another. That is, with enough experience in a variety of situations, all seen from the same perspective but requiring different tactical decisions, the brain of the expert gradually decomposes this class of situations into subclasses, each of which requires a specific response. This allows the immediate intuitive situational response that is characteristic of expertise.

The expert driver not only feels in the seat of his or her pants when speed is the issue but also knows how to perform the appropriate action without calculating and comparing alternatives. On the off-ramp, his or her foot simply lifts off the accelerator and applies the appropriate pressure to the brake. What must be done, simply is done.

The chess grandmaster experiences a compelling sense of the issue and the best move. Excellent chess players can play at the rate of 5 to 10 seconds a move and even faster without any serious degradation in performance. At this speed, they must depend almost entirely on intuition and hardly at all on analysis and comparison of alternatives. It has been estimated that an expert chess player can distinguish roughly 100,000 types of positions. For much expert performance, the number of classes of descriminable situations, built up on the basis of experience, must be comparatively large.

A few years ago, we performed an experiment in which an international master, Julio Kaplan, was required to add numbers presented to him audibly at the rate of about one number per second as rapidly as he could while playing 5-second-a-move chess against a slightly weaker but master level player. Even with his analytical mind completely occupied by adding numbers, Kaplan more than held his own against the master in a series of games. Deprived of the time necessary to see problems or construct plans, Kaplan still produced fluid and coordinated play.

Kaplan's performance seems somewhat less amazing when one realizes that a chess position is as meaningful, interesting, and important to a professional chess player as a face in a receiving line is to a professional politician. Almost anyone could add numbers and simultaneously recognize and respond to familiar faces, even though each face will never exactly match the same face seen previously, and politicians can recognize thousands of faces, just as Julio Kaplan can recognize thousands of chess positions similar to ones previously encountered.

That amateur and expert chess players use different parts of the brain has been confirmed by recent MRI research. The researchers report the following:

> We use a new technique of magnetic imaging to compare focal bursts of γ-band activity in amateur and professional chess players during matches. We find that this activity is most evident in the medial temporal lobe in amateur players, which is consistent with the interpretation that their mental acuity is focused on analyzing unusual new moves during the game. In contrast, highly skilled chess grandmasters have more γ-bursts in the frontal and parietal cortices, indicating that they are retrieving chunks from expert memory by recruiting circuits outside the medial temporal lobe. (Amidzic, Riehle, Fehr, Weinbruch, & Elbert, 2001, p. 603))

It should be noted that the assumption that experts "are retrieving chunk's [i.e., representations of typical chess positions] from memory" is in no way supported by this research. What the research does suggest, however, is the researcher's weaker claim that

> these marked differences in the distribution of focal brain activity during chess playing point to differences in the mechanisms of brain processing and functional brain organization between grandmasters and amateurs. (Amidzic, Riehle, Fehr, Weinbruch, & Elbert, 2001, p. 603)

What is going on in the brain in these different cases is not shown by this data, but phenomenological description shows that a beginner calculates using rules and facts just like a heuristically programmed computer, but that with talent and a great deal of involved experience, the beginner develops into an expert who intuitively sees what to do without recourse to rules. The tradition has given an accurate description of the beginner and of the expert facing an unfamiliar situation, but normally an expert does not calculate. He or she does not solve problems. He or she does not even think. He or she just does what normally works and, of course, it normally works.

Table 1. Five Stages of Skill Acquisition

Skill Level	Components	Perspective	Decision	Commitment
1. Novice	Context free	None	Analytic	Detached
2. Advanced beginner	Context free and situational	None	Analytic	Detached
3. Competent	Context free and situational	Chosen	Analytic	Detached understanding and deciding; involved outcome
4. Proficient	Context free and situational	Experienced	Analytic	Involved understanding; detached deciding
5. Expert	Context free and situational	Experienced	Intuitive	Involved

Note: Components: This refers to the elements of the situation that the learner is able to perceive. These can be context free and pertaining to general aspects of the skill or situational, which only relate to the specific situation that the learner is meeting. Perspective: As the learner begins to be able to recognize almost innumerable components, he or she must choose which one to focus on. He or she is then taking a perspective. Decision: The learner is making a decision on how to act in the situation he or she is in. This can be based on analytic reasoning or an intuitive decision based on experience and holistic discrimination of the particular situation. Commitment: This describes the degree to which the learner is immersed in the learning situation when it comes to understanding, deciding, and the outcome of the situation—action pairing.

The skill model can is summarized in the table above.

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